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ABSTRACT

This study addressed three major questions pertaining to habituation of visual attention in infants: (1) does habituation occur gradually? (2) how do fast and slow habituators compare in their response to discrepancy? and (3) does intervening stimulation produce interference with infants' visual recognition memory? The subjects were 36 17-week-old infants, half were male and half female. Each infant sat on his or her mother's lap facing a semi-circular screen while an observer watched the infant's head and eye movements on a television monitor located in an adjacent room. Each trial consisted of the infant's looking at a blinking light on the left, followed by one unlimited fixation of the stimulus on the right. Each infant saw the same pattern repeatedly until his or her fixation time reached the specified habituation criterion. Each infant was then presented with a pattern discrepant from the standard stimulus. The findings indicated that infants do not gradually decrease their response to a repeated stimulus, but rather seem to habituate within one or two trials. Further, there were distinct, non-overlapping distributions of trials to criterion for the fast and slow habituators with both groups of infants showing the same degree of recovery to a novel stimulus. Finally, evidence of interference with infants' recognition memory was found and attributed to there being only a single, repeated intervening stimulus. (JMB)

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Infant Visual Memory:

The course of true habituation never did run smooth

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Habituation of visual attention has proved to be a useful procedure for investigating information processing and memory in young infants. Generally, habituation refers to a decrement in responding to a repeated stimulation. If an infant is repeatedly shown the same visual pattern, the subject's fixation time to that stimulus eventually decreases. Changing the pattern causes the infant's fixation time to recover (i.e., increase back to its original level). It is generally assumed that habituation requires that the infant process part or all of the information in the stimulus, store that information, and compare subsequent stimuli to the stored representation. If the present stimulus matches the subject's memory model, attention is inhibited. If it presents a discrepancy, the infant responds positively.

Three major questions were addressed in the present study. The first concerned the course of habituation. If infants' fixation times are combined and plotted as group data, one generally obtains a curve showing a gradually decreasing response. However, it is possible that group data obscure what happens with individual infants in the same way that group learning curves do. It may be that habituation does not occur gradually at all, but is instead analogous to one-trial learning.

To investigate this question, it is necessary to specify a criterion of response level, i.e., a criterion of habituation, and then plot data backward from the point at which each subject reaches that criterion. In the present study a proportional criterion was used: an infant was judged to have habituated when his or her fixation time was one-half or less its original level.

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The second major question concerned individual differences in rate of habituation. In any habituation study some subjects habituate very quickly while others continue to look at the stimulus throughout the session. This experiment was designed to compare the response to discrepancy of fast and slow habituators. Previous research has frequently found no recovery by slow habituators, but in those experiments a fixed number of trials was given to all subjects. Thus, slow habituators tended to be infants who had simply not habituated by the end of the session. If response habituation reflects the development of a memory model of the repeated stimulus, one could expect recovery only after an infant has first habituated to the standard. The criterion of habituation used in the present study insured that all subjects decreased their fixation time by the same relative amount. Thus, they differed only in rate of habituation, that is, the number of trials required to reach the criterion.

A third focus of this study consisted of testing for delayed recognition of the stimulus following several intervening trials with a different pattern. It was expected that such intervening stimulation might produce interference with the infants' visual recognition memory, something which has not previously been reported for the habituation paradigm.

The subjects were 36 17-week-old infants, half male and half female. Each infant sat on his or her mother's lap facing a semi-circular screen. A television camera was aimed through the center of the screen at the infant, and an observer watched the infant's head and eye movements on a TV monitor located in an adjacent room. Each trial began with a light on the infant's left blinking on and off. Thr purpose of the light was to control where the infant was looking at the beginning of each trial. As soon as the infant looked at the blinking light, the observer pressed a switch, causing the light to go off and a slide co be projected on the infant's right. The pattern remained on until and as

long as the infant fixated it. When the infant turned away from it, the slide was turned off and the blinking light came on, starting the next trial. Thus, each trial consisted of the infant's looking to the blinking light on the left, followed by one unlimited fixation of the stimulus on the right.

On the first two and last two trials every infant saw a black and white 8 x 8 checkerboard. The first two presentations were warm-up trials to familiarize the infant with the experimental situation. The last two presentations tested to see if the infant had remained generally attentive throughout the session. It is necessary in any habituation study to make certain that the infant's response to the repeated stimulus did not decrease simply because the child was becoming fatigued, fussy, etc. The infants in the present study actually looked at the checkerboards at the end of the experiment longer than at the beginning. Thus, we can conclude that they were still generally alert at the end of the session.

The standard stimulus for the habituation trials was one of two patterns, both of which contained four colored geometric shapes on a black background. Each infant saw the same pattern repeatedly until his or her fixation time reached the specified criterion. A special computer added together the infant's fixation time on the first three presentations of the standard stimulus and then compared the sum of every three consecutive trials with it (including trials 2, 3, and 4). When the infant's fixation time for any three trials was one-half or less the sum of his or her first three trials, the infant was judged to have habituated. Thus, all infants decreased their fixation time by the same relative amount, one-half, but the number of trials required to reach this criterion could vary from one infant to another.

One of the most striking findings of this study was the distinctly bi-modal distribution of trials to criterion, as shown in Figure 1. One group of infants

(designated as fast habituators) took eight or fewer trials to habituate, while a separate group (slow habituators) required eleven or more trials to reach criterion. The two distributions do not overlap, and approximately half the subjects were in each group. Thus, rate of habituation appears to identify two quite different populations of infants.

After reaching the criterion of habituation, each infant was presented with a pattern that was discrepant from the standard stimulus. There were three levels of discrepancy, high, medium, and zero. Sex and standard stimulus were counterbalanced relative to the three discrepancy conditions. For the high discrepancy condition, the new pattern contained all new colored shapes. Thus, infants who had previously seen standard A now received standard B, and vice versa. In the medium discrepancy condition, half the colored shapes in the pattern were new and half had been in the previous standard. The zero change group continued to see the same pattern which they had already seen during the habituation trials. This condition was to control for the possibility that some infants might reach the habituation criterion by chance; they might emit three consecutive but randomly low responses due to response fluctuation rather than to habituation. If this were the case, one would expect the infants' fixation time to increase again following the chance low trials. On the other hand, if the infants had really habituated, one would expect their response to the standard to remain low.

Figure 2 shows the results obtained for the infants' response to the discrepant stimuli. The last two habituation trials were compared to the first two presentations of the novel pattern. Both the medium and high discrepancy groups showed significant recovery to the changed stimulus. The fixation time for the zero discrepancy group did not change. Thus, it can be concluded that chance attainment of criterion was not a serious problem in this study.

Figure 2 does not break down the response to discrepancy for fast and slow habituators because there was no difference between the two groups. Both fast and slow habituators showed significant recovery in the high and medium change conditions, and there was no difference in the degree to which their fixation time increased.

These data suggest that although the two groups of infants differed greatly in the number of trials it took them to form an accurate model of the stimulus, once that model was formed well enough to inhibit further looking at the pattern, they were equally capable of discriminating a new stimulus from the old one. Thus, the main difference between fast and slow habituators appears to be in the functions of analyzing and/or encoding stimulus information, rather than in retrieval or comparison processes.

Further support for this view is provided by the analysis of the course of habituation. Figure 3 shows the infants' mean fixation time plotted backward from the point at which each subject reached the criterion of habituation. Since even within the same group some infants took more trials to reach criterion than did others, the number of scores contributing to each point on the curve varies somewhat. However, no point contains fewer than half the subjects in each group.

It is immediately obvious that these data do not correspond to any conception of habituation as a gradual decrement in response to repeated stimulation. Rather, it appears that the response decrement occurs quite precipitously. Both fast and slow habituators seem to respond to the stimulus fairly consistently for varying numbers of trials, but then habituate to it within one or two trials. We know that they actually habituated, because the fixation time of those infants who continued to see the same stimulus remained at the same low level. The fast and slow habituators differ in the number of stimulus presentations before they

habituate, but they both show the same sudden drop in fixation time.

The infants in the high and medium discrepancy conditions continued to see the discrepant stimulus until they habituated to it or for eight trials, whichever came first. They were then shown their original habituation standard stimulus (either A or B) to test if they still recognized it. If so, one would expect their fixation time to be low as it had been at the end of habituation. If they did not recognize it, one would expect their fixation time to recover above the habituated level.

On the recognition test the infants looked at the standard significantly longer than they had at the end of the habituation trials. This suggests that the intervening trials had interfered with the subjects' memory for the habituation stimulus. The main difference between this study and several others which have failed to find interference with infants' recognition memory is that in the present experiment only one intervening stimulus was presented and it was shown repeatedly. It may be that interference only occurs when the intervening stimulus gets into memory. Thus, several presentations of a single stimulus are necessary to produce interference, and it may also be necessary that the infant habituate to the intervening stimulus.

Obviously this hypothesis needs to be tested systematically in an experiment in which infants are habituated to one stimulus and then given several trials with either only one repeated stimulus or with several different patterns. Such a study is currently in progress in our laboratory. Preliminary data indicate that the only infants who fail to remain habituated to the original standard stimulus are those who received only one repeated intervening stimulus and who habituated to that pattern.

In summary, this study found distinct, non-overlapping distributions of trials to reach criterion for fast and slow habituators. Both groups of infants

showed recovery to a novel stimulus, and there was no difference in the degree of recovery for the two groups. Plotting data backward from criterion revealed that "the course of true habituation never did run smooth." Infants do not gradually decrease their response to a repeated stimulus, but rather seem to habituate within one or two trials. Finally, evidence of interference with infants' recognition memory was found and attributed to there being only a single, repeated intervening stimulus.

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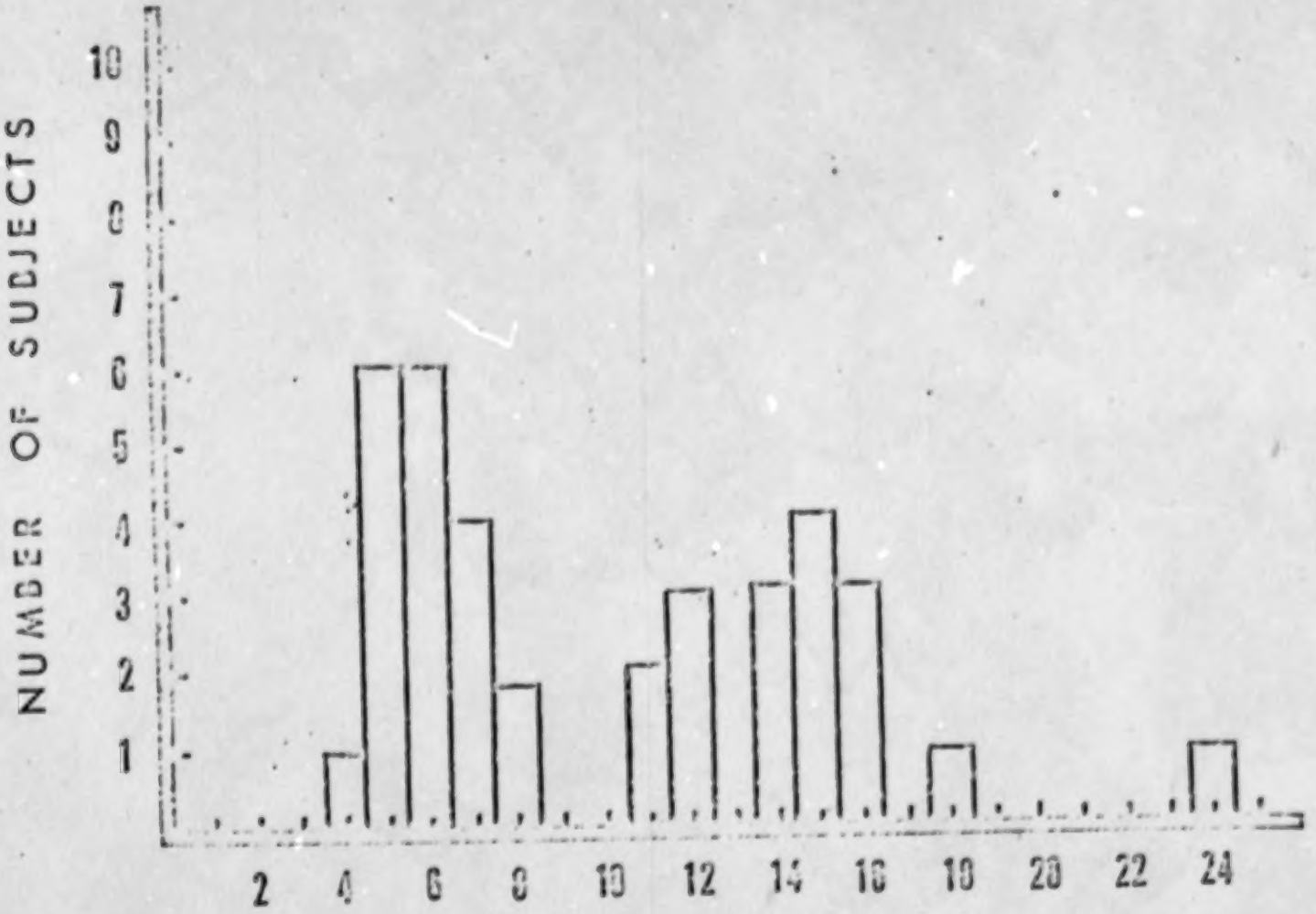

Figure 1. Distribution of number of trials to criterion. Subjects taking 8 or fewer trials to reach criterion were designated as fast habituators, and those taking 11 or more trials were slow habituators.

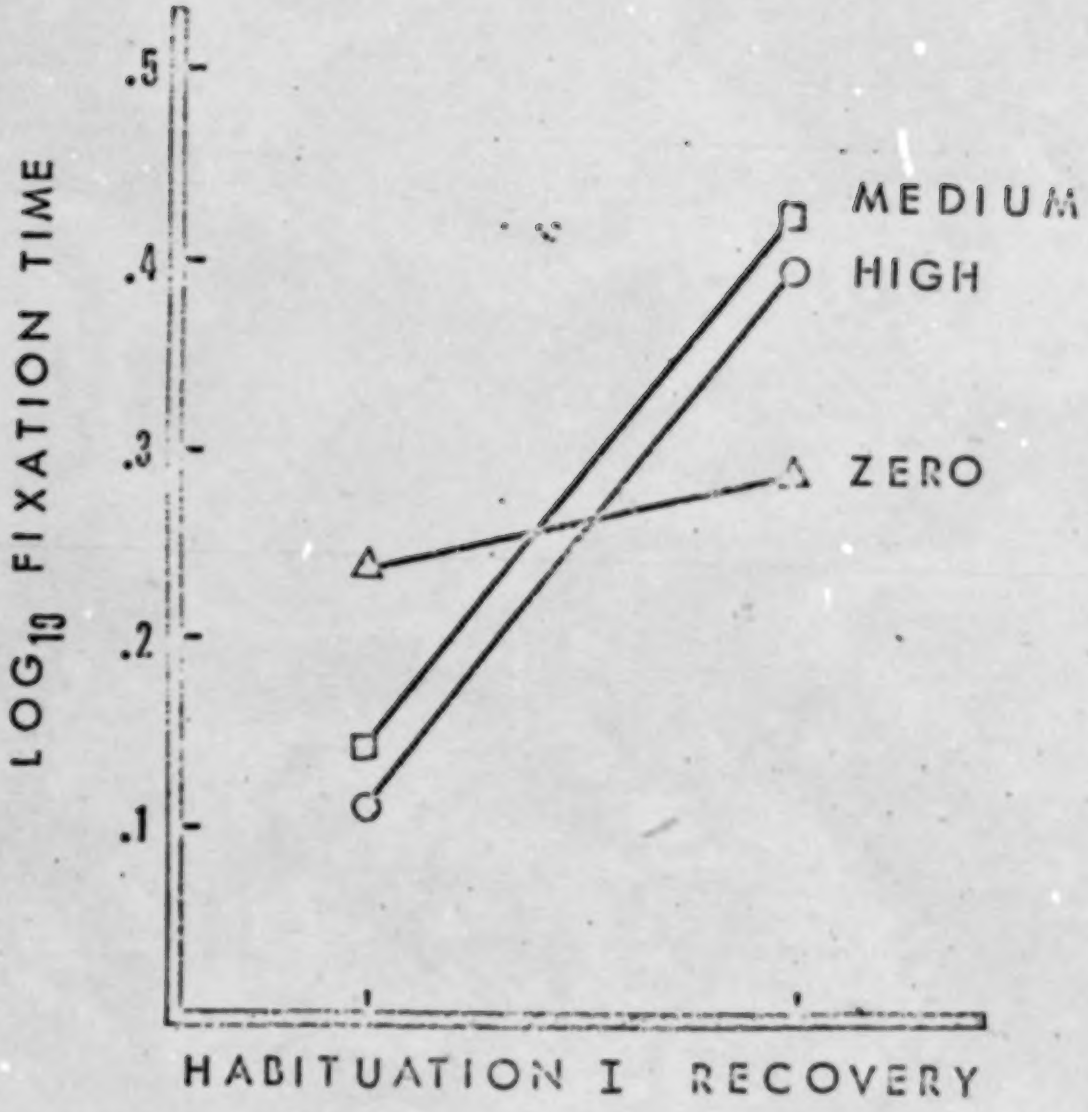

Figure 2. Recovery to discrepancy.

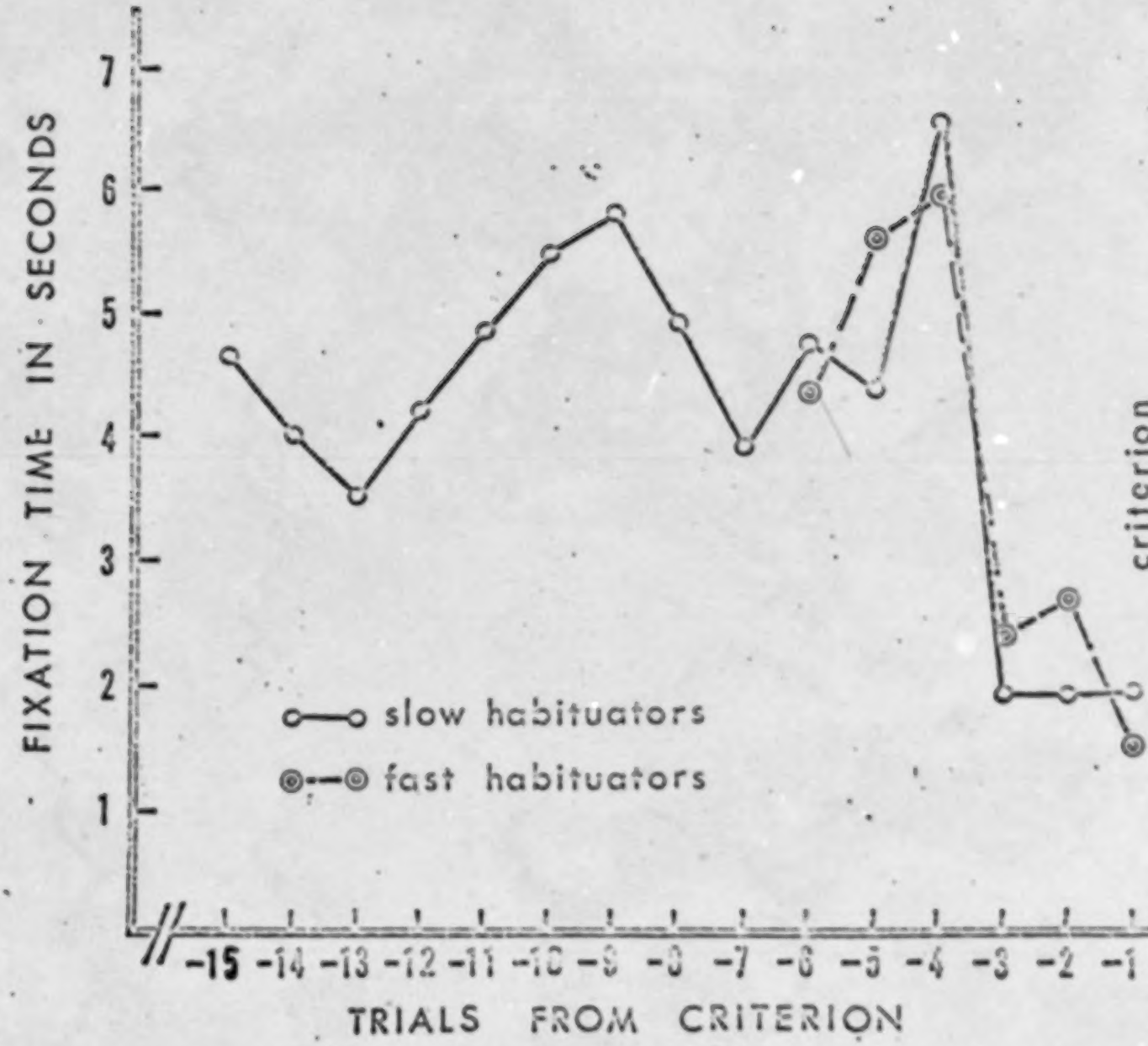

Figure 3. Habituation curves plotted backward from the point at which each subject reached criterion.